Man 230

VWnote
User Manual

Soil Instruments Limited has an ongoing policy of design review and reserves the right to amend these specifications without notice.

What's this manual about?

This manual tells you about the VWnote and how to use it to take readings from VW sensors.

Who does this apply to?

Installers, field engineers and technicians who need to acquire readings from VW sensors and to maintain the VWnote system.

Welcome!

Thank you for choosing the VWnote.

This manual has been written to help you utilise all of the functions of the VWnote. Please read this manual thoroughly before use to help avoid any problems and keep it handy when using the VWnote.

VWnote

The VWnote is a handheld device which takes readings from Vibrating Wire (VW) sensors and stores them on an internal memory for retrieval later via a USB pen drive. It uses the Fast Fourier Transformation (FFT) based reading algorithm, which not only gives more reliable readings, but also gives the user the ability to check the quality of each reading, rejecting it when there is too much interference. The VWnote can read almost all commercially available vibrating wire sensors.

Built with state-of-the-art electronic components and the latest firmware technology, each VWnote comes with many powerful built-in functions. These functions will allow you to customise how readings from each sensor are taken, displayed, stored and managed in order to assure correct and repeatable readings every time.

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PRECISELY MEASURED

instrumentation and monitoring

Part I – General User Guide

Contents

This section contains the following topics.

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Introduction:
Important information

The following symbols are used throughout the manual

IMPORTANT INFORMATION

WARNING

TIP

! Important: Failure to adhere to the warnings in this manual may result in network disruption and possible data loss.

Failure to observe the warning may result in injury, product malfunction, unexpected readings or damage to the product that may invalidate its warranty.

Tips give additional information that may be helpful when using VWnote.

PRODUCT CHANGES

Soil Instruments has an on-going policy of design review and reserves the right to amend the design of their product and this instruction manual without notice.

WARRANTY

Refer to our terms and conditions of sale for warranty information. The batteries are a consumable item and are excluded from the warranty.

DISPOSAL

Products marked with the symbol are subject to the following disposal rules in European countries:

- **This product is designated for separate collection at an appropriate collection point**
- **Do not dispose of as household waste**
- **For more information, contact Soil Instruments or the local authority in charge of waste management**

System Description
Things You Need to Know About VWnote

FEATURES

- Portable and rugged
- Compatible with most commonly used VW sensors
- Real-time display of VW sensor readings in engineering units as well as in Hz, $Hz^2/1000$ and period
- FFT-based data reading algorithm for interference-free readings
- Reads with the default full sweep frequency range (450-6000Hz) or any user definable range
- Fully configurable reading and displaying parameters of each sensor
- Large data storage (2GB) and easy data retrieval via a USB pen drive
- Firmware upgradable via USB pen drive by the user – no need for a PC and no need to return it back to factory
- Powered by a Nickel Metal Hydride (NiMH) rechargeable battery, 30 hours without backlight and 15 hours with backlight. User selectable backlight for the display, auto shutdown after six minutes of inactivity.

BENEFITS

- Powerful features in a rugged and portable package; makes it easy to carry and operate in all site conditions
- Advanced FFT-based reading algorithm ensures readings are accurate, repeatable and free from interferences
- Easy to follow menu makes taking readings on site simple, fast and error free
- The optional 15 VDC excitation, which provides higher energy excitation than the default excitation of 5 VDC, ensures quality readings for sensors with long cables
- A site ID and a sensor name are assigned to each sensor. This facilitates management of a large quantity of VW sensors from a large site or multiple sites
- Saved readings are grouped by dates which, together with the large internal memory, minimises data loss
- Each reading is displayed and recorded with readings in raw and engineering units together with reading quality indices and optional waveform data. This ensures that each reading is quality assured
- The VWnote does not require a PC in the field to set up or download data, which means users of VWnote do not need to carry a site PC nor need to be computer literate to use VWnote.

System Components

THE VWNOTE

The VWnote is a handheld readout unit as well as a data logger for VW sensors. Below is a picture of the VWnote showing the various parts that you will use to interact with it.

USB PEN DRIVE

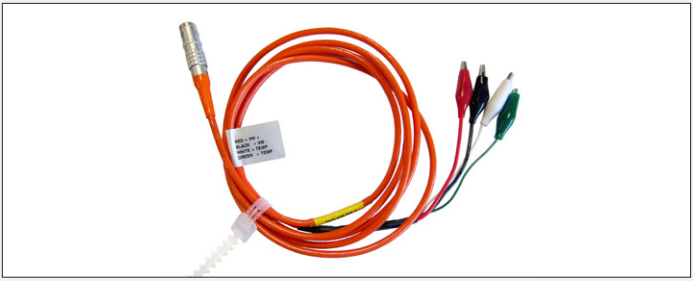
Each VWnote will be supplied with a USB pen drive. Apart from being the distribution medium for the VWnote Configuration Tool software, you can also use it for data off-loading from the VWnote, as well as importing the configuration file to, and exporting it from, the VWnote.

VWNOTE CONFIGURATION TOOL SOFTWARE

Distributed on the USB pen drive with every VWnote is the VWnote Configuration Tool. This is a Windows-based software that you will use to create and edit the sensor configuration file, which will contain information on how readings from each sensor will be read, displayed and stored.

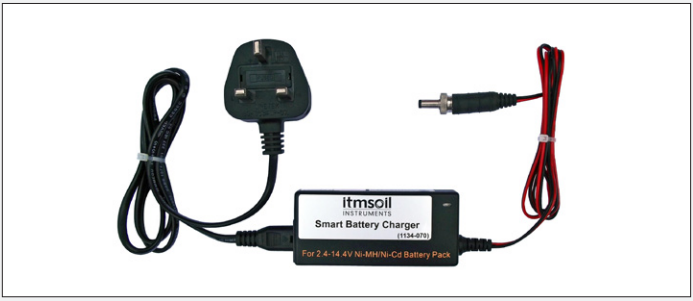
VW SENSOR LEAD

The VW sensor lead is shown in the picture below. One end of the lead has a Lemo plug that you will plug into the sensor connector on the top left of the VWnote. On the other end of the lead are four crocodile connectors coloured red, black, green and white, for connecting to the wires in the signal cable of a sensor with matching colours.



RECHARGEABLE BATTERY & CHARGER

The VWnote contains a Nickel Metal Hydride (NiMH) rechargeable battery and is supplied with a trickle charge battery charger.



VWNOTE CARRY CASE

The VWnote is supplied with a padded carry case with shoulder strap and pockets for the sensor connecting lead and the USB pen drive. We recommend that you carry and store the VWnote in the carry case whenever it is not being used.

Quick Start Guide

BEFORE YOU GO TO SITE:

1. Place the VWnote on charge, ensuring that you follow the charging procedure outlined in ***Part 11 - Detailed VWnote user Guide - Charging the VWnote***
2. Switch on the VWnote.
3. Select '**DATE/TIME**' from the main menu to set the VWnote internal clock to the current date and time.
4. Select '**INFO**' to confirm that the firmware version is V1.17 or later. If the firmware needs updating, follow the instructions for firmware update in ***Part IV*** of this manual.
5. Test the reading function as follows:
   - Connect a VW sensor to the VWnote using the sensor lead
   - Go to 'READ' in the main menu and select 'DEFAULT' on the top of the site list and 'DEFAULT_VW' from the top of the sensor list
   - Press ➔ to start reading
   - Check the VW reading and the temperature reading

Follow the troubleshooting guide in ***Appendix C*** in ***Part V*** of this manual if the readings are unstable or incorrect.

6. If you have a pre-prepared configuration file containing your custom sensor list, go to '**CFG IMPORT**' in the main menu to load the sensor list into the VWnote (for more details, see ***CFG IMPORT*** in ***Part II*** of this manual).
7. Switch off the VWnote by going to '**OFF**' in the main menu and pressing ➔.
8. Unplug the sensor lead from the VWnote. Replace the sensor connector cap and the USB port cap.
9. Place the VWnote in its carry case along with the sensor lead and a pen drive, ready to take to site.

WHEN YOU ARE IN THE FIELD:

1. Remove the VWnote from its carry case.
2. Switch on the VWnote, go to '**READ**' in the main menu and follow the procedures below to take a reading:
   - Connect a VW sensor to the VWnote using the sensor lead
   - Select your site from the site list and then your sensor from the sensor list

- If you do not have a pre-prepared sensor list, you can read the VW sensor by selecting '**DEFAULT_VW**' from the sensor list, or you can add sites and sensors by going to '**SETUP**' in the main menu (please refer to *Part II* for detailed instructions)
- Press → to start reading
- If necessary, press → again to view the reading quality indices. Press ← to return to the readings
- Press '**Save**' to send the current readings to the VWnote internal memory
- Press ← once to return to the sensor list to select another sensor from the same site, or press ← twice to go to the site list to select another site
- Disconnect the sensor cable from the crocodile clips

3. Repeat the procedures in Step 2 for any other sensors you wish to read, taking care to ensure that the sensor you are reading matches with the unique site and sensor ID in the VWnote.
4. After you have finished taking readings for the current site, you can transfer the data straightaway to a pen drive in the field without the need for a site PC as follows:
   - Plug a USB pen drive into the USB port on the bottom of the VWnote
   - Go to '**DATA TO USB**' in the main menu, and then press → to display '**DO NOT ERASE INTERNAL DATA**'
   - Press ↑ and ↓ arrows to select between '**DO NOT ERASE INTERNAL DATA**' and '**ERASE INTERNAL DATA**' before pressing '**Save**' to initiate the transfer
   - The transfer is successful when the VWnote displays '**DATA SAVED TO USB**'. Press →
5. **Before you move to the next sensor location or the next site, please ensure that you disconnect the sensor lead from the VWnote, replace all caps and return the VWnote back to its carry case for safe transport.**

BACK IN THE OFFICE:

1. If you have not already downloaded the data to a pen drive (see Step 4 above), then do so now.
2. Transfer the data on the USB pen drive to a PC for further transfer or processing.

Please refer to ***Part II – Detailed VWnote user guide*** in this manual for more details of each step.

Part II – Detailed VWnote User Guide

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This section contains the following topics.

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Charging the VWnote

The VWnote is supplied with a Nickel Metal Hydride (NiMH) rechargeable battery. It is important to follow the charging procedure outlined below at all times to correctly maintain the battery.

STEP	ACTION
1	Make sure the VWnote is switched off
2	Remove the protective cap from the charging point, located on the top of the VWnote
3	Plug the connector into the charging point on the VWnote, making sure to align the connections correctly
4	Plug the charging unit into a mains power socket
5	Switch on the mains power to the charging unit
6	The LED on the charging unit will follow the sequence outlined in the table below
7	Place the protective cap back into the charging point on the VWnote when charging is complete

Charging Unit LED Sequence

STEP	LED	STATUS
1	Red - Green	Analysing battery status
2	Red - Green	
3	Red	Charging in progress
4	Green	VWnote charged; switched to trickle charge mode

Follow the charging procedure outlined in this manual at all times to properly maintain the battery.

Connecting Sensors to the VWnote

You can connect only one Vibrating Wire sensor at a time to the VWnote; this sensor can be with or without a built-in temperature sensor.

VW SENSOR WITH BUILT-IN TEMPERATURE SENSOR

All sensor connections to the VWnote are made via the Lemo plug which is located under a cap on the top of the VWnote; see figure below:

CLIP COLOUR	SENSOR TERMINAL
Red	VW +
Black	VW -
Green (or Blue)	Temperature +
White	Temperature -

Consult the sensor user manual for the sensor connections.
If you are still unsure, please contact Soil Instruments.

Please ensure that the bare parts of the clips do not touch each other and cause shorts among the four wires.

VWnote is only compatible with the 3K ohm thermistor temperature sensors. It will not work with the RTD-based temperature sensor in some of the VW sensors.

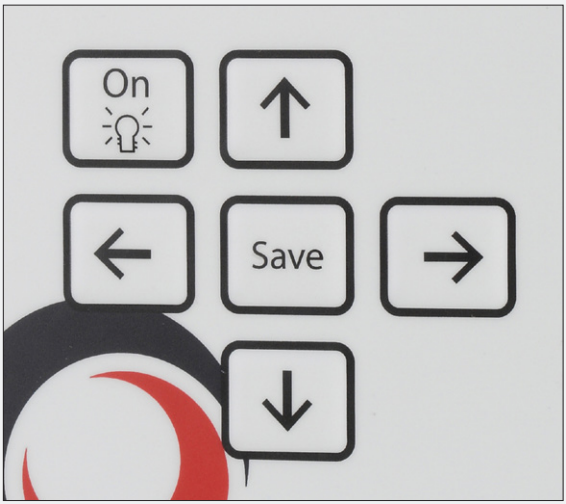
VW SENSOR WITHOUT BUILT-IN TEMPERATURE SENSOR

For a VW sensor without built-in temperature sensor, only connect the sensor to the red and the black crocodile clips.

Only a qualified person trained in the use of VWnote and the VW sensors may connect sensors.

How to Use the Keypad

Below is a picture showing the keypad of the VWnote. Each key on the keypad has multiple functions depending on its context within the VWnote menu.

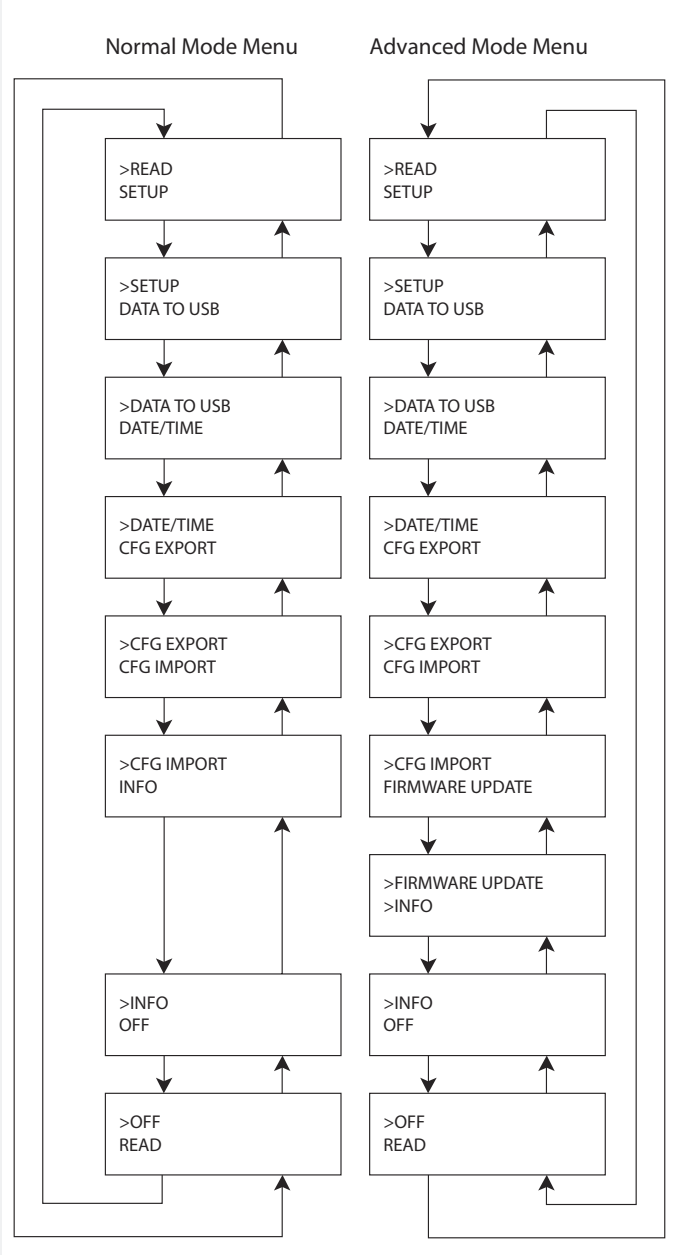


KEY	FUNCTION
On	The On button has two functions: 1. When the VWnote is off, pressing it turns the VWnote on. 2. When the VWnote is already on, pressing it will toggle the LCD displays backlight between on and off.
Up (↑)	The ↑ key acts as an 'up' instruction in the situations below: 1. It moves the cursor up in the currently displayed list such as the main menu, list of sites, list of sensors, current readings, quality indices and various reading and display parameters. 2. It increases the value of the current field when updating date/time. 3. It moves upward through a list of alphanumeric letters when the site name, sensor name and sweep frequency are entered one character at a time.

KEY	FUNCTION
Down (↓)	The ↓ key acts as a 'down' instruction in the situations below: 1. It moves the cursor down in the currently displayed list such as the main menu, list of sites, list of sensors, current readings, quality indices and various reading and display parameters. 2. It decreases the value of the current field when updating date/time. 3. It moves downward through a list of alphanumeric letters when the site name, sensor name and sweep frequency are entered one character at a time.
Left (←)	The ← acts as a back instruction or 'NO' to a question. When a menu option is selected or a question is displayed on the screen, pressing this key will take you back to the previous menu selection.
Right (→)	The → acts as a 'next' instruction in the situations below: 1. When a menu option is displayed, pressing this key will take you to the next screen or stage of the menu functions. For example, when pressed while **READ** is selected, this key takes you to the list of sites; when a sensor is selected, this key will take you to the sensor reading screen. 2. When VWnote asks you to enter a site name, a sensor name, a frequency, this key will take you to the next character position. 3. When VWnote asks you to change date/time, this key will take you to the next field.
Save	The Save button has several functions: 1. When you set a new **DATE/TIME** for the VWnote, it commits the change to VWnote memory. 2. When you use **SETUP** to enter or edit reading, displaying and calibration parameters of a sensor in the sensor list, it commits the changes to VWnote memory. 3. When the sensor reading is displayed, it saves the latest reading. 4. It is also used as **YES** in response to the question '**ARE YOU SURE? YES(Save)/No(←)**'. For example, when **CFG EXPORT** or **CFG IMPORT** is selected by pressing →, you will need to press **Save** to confirm that you want to proceed with the exporting or importing.

Menu Structure

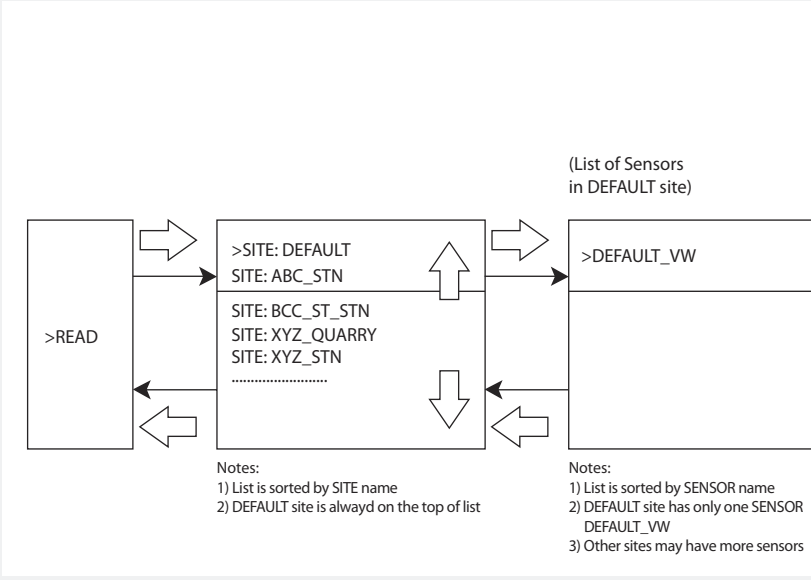
MAIN MENU



READ	Select this menu item to take a reading of the VW sensor that is currently connected to the VWnote.
SETUP	Select this item to add sensors to the list of sensors or to edit the reading and displaying parameters and calibration factors of an existing sensor.
DATA TO USB	Select this menu item to transfer data stored in the VWnote internal memory to the USB pen drive that is plugged into the VWnote USB port.
DATE/TIME	Select this menu item to display the date and time of the real-time clock in the VWnote and to update it when necessary.
CFG EXPORT	Select this option to copy the sensor list in the VWnote to the USB pen drive plugged into the VWnote USB port. If you add sensors or revised the sensor configuration in the VWnote using the keypad, you will need to make a copy of the new sensor configuration to the USB pen drive for backup or for further editing on your PC.
CFG IMPORT	This option is used to copy a new sensor configuration file from a USB pen drive to the VWnote, overwriting the existing sensor configuration in the VWnote.
FIRMWARE UPDATE	This option is only available in the Advanced Mode. You only need to perform a firmware update when instructed to do so by our support department. Instructions on how to access the Advanced Mode and how to perform firmware update will be provided.
INFO	Choosing this option to display the following information about the VWnote: • **Serial number (S/N) of the VWnote** • **Version number and version date of firmware** • **Unit date and time** • **Battery Voltage** • **Storage (free) in %** • **Storage (used) in %** You can press the ↑ and ↓ arrows to scroll through the information.
OFF	To avoid accidental power down, the VWnote does not have an OFF button. You can switch off the VWnote by choosing '**OFF**' in the menu and then pressing →. You will see a message saying '**POWER OFF. Bye! See you later!**' before the unit switches off. As a power conservation measure, the VWnote will switch itself off automatically after six minutes of inactivity.

You can navigate through the main menu by pressing ↑ and ↓. The selected menu item is shown by a > in front of it.

The READ Menu

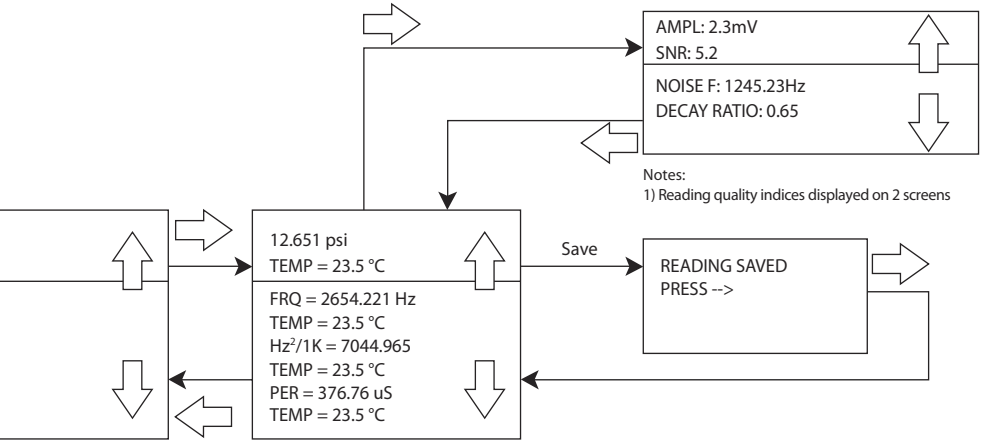


LIST OF SITES

1. The list of sites you specified will be displayed on the LCD screen, two sites per screen and sorted alphabetically. Use ↓ and ↑ to navigate up and down the list.
2. The top of the list is always '**DEFAULT**', which is hard coded in the VWnote and cannot be changed by the user.

LIST OF SENSORS

1. The list of sensors you specified in the site you selected will be displayed on the LCD screen, two sensors per screen and sorted alphabetically. Use ↑ and ↓ to navigate up and down the list.
2. If you select the '**DEFAULT**' site, the top of the list is always '**DEFAULT_VW**', which is hard coded in the VWnote and cannot be changed by the user.
3. The '**DEFAULT_VW**' is a generic sensor created in the VWnote for you to use to read VW sensors before you have the chance to set up a sensor list in the VWnote.



Notes:
1) VW readings displayed on four screens
2) First line of first screen is reading in engineering unit
3) Other screens are readings in raw unit

Sensor '**DEFAULT_VW**' uses the following default parameters of reading and displaying:

- Site name: DEFAULT
- Sensor name: DEFAULT_VW
- Sweep frequency: 450-6000 Hz
- Excitation V = 5V
- Display Resolution = 0.001
- Unit (raw) = $Hz^2/1K$
- Unit (eng) = $Hz^2/1K$
- R0=0
- G=-1
- Calibration=linear
- Unit (temp)=°C.

In most cases, the '**DEFAULT_VW**' sensor will allow you to take readings from most type of VW sensors before you have the chance to define a sensor list for the VWnote.

SENSOR READING

After you have selected which sensor to read by pressing →, the readings of the currently connected VW sensor will be displayed on four consecutive screens:

1. Screen 1 – The VW reading in engineering units (as calculated using the raw reading and the calibration factors and zero reading you specified) and temperature reading in °C (or °F).
2. Screen 2 – The VW reading in Hz and temperature reading in °C (or °F).
3. Screen 3 – The VW reading in $Hz^2/1000$ and temperature reading in °C (or °F).
4. Screen 4 – The VW reading in period (µS) and temperature reading in °C (or °F).
5. You can navigate among the four screens by pressing ↑ and ↓. The readings will be automatically refreshed every two seconds.

Due to limited display space on the LCD screen, $Hz^2/1000$ is displayed as $Hz^2/1K$.

If no sensor is connected, or the sensor or signal cable is faulty, Screen 1 will display '**No VW sensor?**' and/or '**No Therm. Sen.?**' alerting you to the problem. In this case, you will not be able to navigate away from the first screen.

READING QUALITY INDICES

When the readings of the VW sensor are displayed, you can press → to view the four '**reading quality indices**' as follows:

1. **AMPL** – **AMPL** is short for amplitude. It is an index for the signal strength from the sensor.
2. **SNR** – **SNR** is an acronym for '**Signal to Noise Ratio**'. It is an index for the sensor signal strength in relation to the noise signal strength.
3. **NOISE F** – This is the frequency of the noise signal.
4. **DECAY RATIO** – This is an index of how quickly the signal becomes weaker.
5. The **AMPL** and **SNR** are displayed on the first screen and **NOISE F** and **DECAY RATIO** are on the second screen. You can navigate between the two screens by pressing ↑ and ↓. Pressing ← will take you back to the sensor readings screen.

Any time-varying signal (a musical sound for instance) will be composed of one or more component frequencies of different amplitudes.

The Fast Fourier Transform (FFT) algorithm is a fast and efficient method of determining what those component frequencies are, along with their respective amplitudes.

below is some simple guidance on how these indices can be used to determine the quality of the reading.

1. **AMPL**: The value of this index depends on the type of sensor but it should be more than 0.5 mV.
2. **SNR**: When the signal is good and noise is low, this value will be 200, 500, or more. It can drop to single figures in a very noisy environment. Based on experience, any reading with **SNR** less than 5 should be ignored and re-taken.
3. **NOISE F**: Ideally, this value should be far away from the sensor reading in Hz. If this value is very near the sensor reading you expect, then the result you are getting may be invalid.
4. **DECAY RATIO**: The value of this index is dependent upon the type and quality of the sensor. The value should be between 0 and 1 (representing 0%-100%). While the higher the value the better, a value greater than 1 would suggest a bad sensor.
5. When you encounter unstable readings, you should check the four quality indices to determine whether the reading is good. If not, then you should take another one. For quality assurance, these four indices are saved with the sensor readings.

SAVE

1. Pressing the '**Save**' key while you are on the sensor reading screen will send the current VW readings, temperature reading and the reading quality indices with time stamp to the VWnote internal memory. VWnote will display '**READING SAVED. PRESS** ← ' to acknowledge the readings have been saved successfully.
2. Pressing → will take you back to the sensor reading. From there you can save another set of readings for the same sensor, or you can press ← to return to the sensor list to select another sensor to read.

The SETUP Menu

SET UP

You can enter a new sensor configuration into VWnote or edit the existing sensor configuration in the VWnote using the keypad on the VWnote. The process is slow because there are only six keys on VWnote. It is designed for use on site when you need to add sensors or change the sensor configuration in an emergency. To set up sensor configuration in bulk, please use the VWnote Configuration Tool (more details are in ***Part III***).

LIST OF SITES

1. The list of sites you specified will be displayed on the LCD screen, two sites per screen and sorted alphabetically. Use ↑ and ↓ to navigate up and down the list.
2. The top of the list is always '**ADD A SITE**'; when selected it will allow you to add a new site to the list of sites in the VWnote.
3. Press → to display a screen where you can enter a site name.
4. While you are on this screen, press → to go to the next character position, press ↑ and ↓ to go through the valid letters (A-Z, 0-9 and "_"). After you have entered the site name, press '**Save**' to enter the site name into VWnote.

The site name is limited to 10 characters and can contain only A-Z, 0-9 and "_".

Pressing ← during entry or edit will not move the cursor one character to the left. It will cancel the entry or edit and take you back to the previous menu.

LIST OF SENSORS

1. The list of sensors in the site you selected will be displayed on the LCD screen, two sensors per screen and sorted alphabetically. Use ↑ and ↓ to navigate up and down the list.
2. The top of the list is always '**ADD A SENSOR**'; when selected it will allow you to add a new sensor to the list of sensors for the site you selected.
3. Press → to display a screen where you can enter a sensor name. After you have entered the sensor name, press Save to enter the site name into VWnote.
4. While you are on this screen, pressing → will move the cursor to the next character position; press ↑ and ↓ to go through the valid letters (A-Z, 0-9 and "_").

The sensor name is limited to 15 characters and can contain only A-Z, 0-9 and "_".

Pressing ← during entry or edit will not move the cursor one character to the left. It will cancel the entry or edit and take you back to the previous menu.

The name of each sensor should be in the '**Site + Sensor**' format. This will allow you to manage the sensors and their readings more efficiently by grouping them according to site names and with the sensors arranged in alphabetical order.

CONFIGURE A NEW SENSOR

After you add a new sensor VWnote will automatically assign the following default values to the reading and displaying parameters listed below:

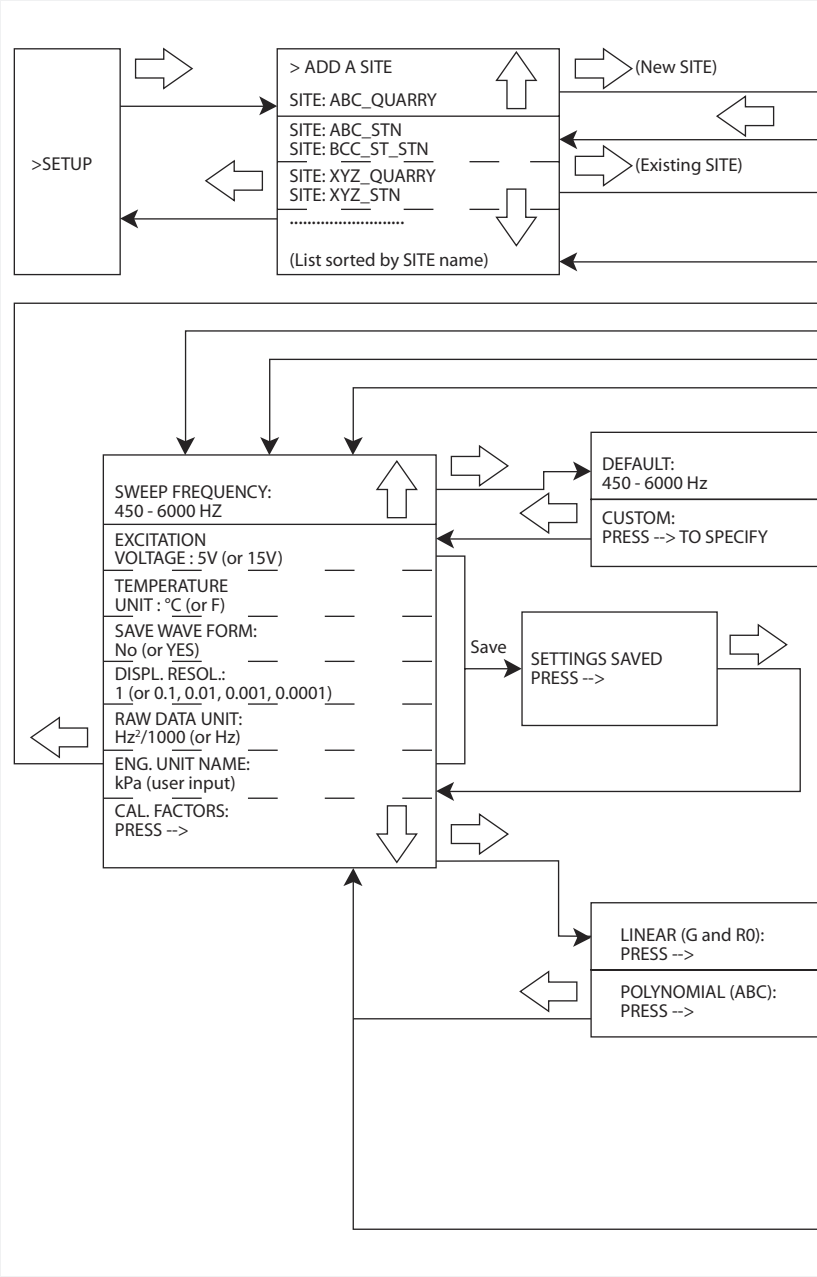
- Sweep frequency = 450-6000Hz
- Excitation V = 5V
- Unit (temp) = ºC
- Save wave form = No
- Display Resolution = 0.001
- Unit (raw) = $Hz^2/1000$
- Unit (eng) = blank
- Calibration = linear
- R0 = 0
- G = -1.

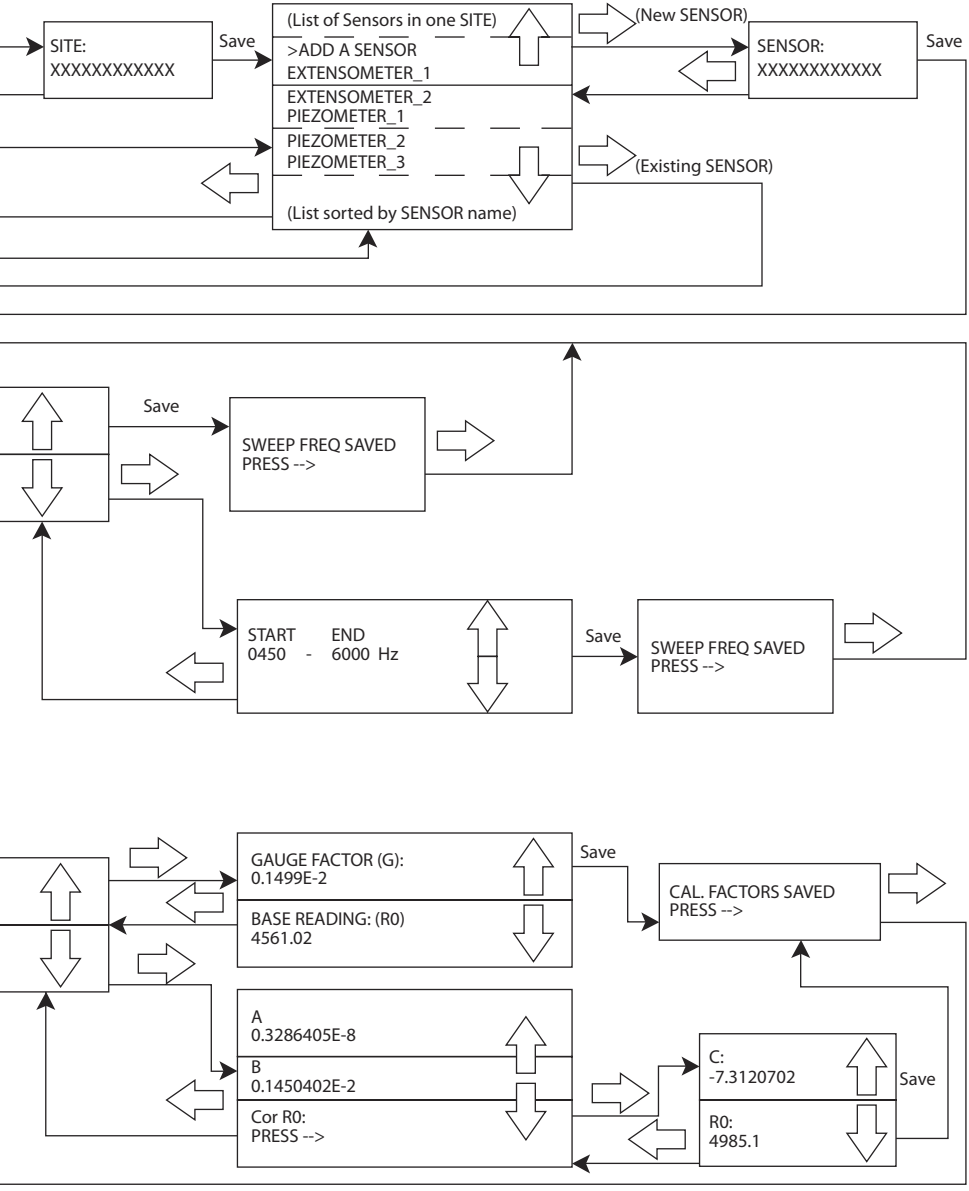
More detailed descriptions on these parameters are given in the next section. By pressing → once, you can view and revise the values of the above sensor parameters.

CONFIGURE AN EXISTING SENSOR

After you have selected an existing sensor from the sensor list from the selected site, press → once to view and revise the value of the sensor configuration parameters stored in the VWnote.

FLOW DIAGRAM




SITE:
XXXXXXXXXXXX
Save
(List of Sensors in one SITE)
>ADD A SENSOR
EXTENSOMETER_1
EXTENSOMETER_2
PIEZOMETER_1
PIEZOMETER_2
PIEZOMETER_3
(List sorted by SENSOR name)
(New SENSOR)
SENSOR:
XXXXXXXXXXXX
Save
(Existing SENSOR)
Save
SWEEP FREQ SAVED
PRESS -->
START END
0450 - 6000 Hz
Save
SWEEP FREQ SAVED
PRESS -->
GAUGE FACTOR (G):
0.1499E-2
BASE READING: (R0)
4561.02
Save
CAL. FACTORS SAVED
PRESS -->
A
0.3286405E-8
B
0.1450402E-2
Cor R0:
PRESS -->
C:
-7.3120702
R0:
4985.1
Save

How to Set Up Sensor Configuration

The following eight parameters define how each sensor is read and how the readings are displayed. The current settings for these parameters are presented on eight screens that you can scroll through using ↑ and ↓. Pressing → while each parameter is displayed will take you to further screens where you can edit their values.

1. SWEEP FREQUENCY:

- At the top of the list of sensor configuration parameters is the range of sweep frequency currently used by VWnote to read this sensor.
- Press → to open up another screen to select the default range or to define a custom range (using ↑ and ↓).
- If you select the custom range and press →, you will be presented with another screen where you can enter the start and end frequencies.
- When entering a sweep frequency, use → to move the cursor to the next character position and use ↑ and ↓ to move through 0-9. Press the Save key to confirm the edit, or ← to cancel the change and return back to the previous screen.

Pressing ← during entry or edit will not move the cursor one character to the left. It will cancel the entry or edit and take you to the previous menu.

In most cases, the default sweep frequency range (450-6000 Hz) works well because VWnote uses FFT reading algorithm to derive readings from the sensor. Optionally, you can customise the sweep frequency to any range between 450 Hz and 6000 Hz, such as 450-1250 Hz or 1200-2800 Hz.

VWnote will issue error messages if you enter a frequency that is less than 450 Hz, greater than 6000 Hz, or if the end frequency is less than the start frequency.

2. EXCITATION VOLTAGE:

- The default excitation voltage that VWnote uses to energise the sensor before taking a reading is 5 V. This is sufficient for most site conditions where the sensors have a short cable length
- You can select the optional 15 V excitation if the sensor has a long cable
- Press → to toggle between 5 V and 15 V. Press '**Save**' to commit the change to VWnote or ← to cancel.

The maximum cable length that 5 V excitation will work is dependent on factors such as the gauge size of the wires. However, as a rule of thumb, cable lengths greater than 200m (600ft) are usually considered to be long.

3. TEMPERATURE UNIT:

- The default temperature unit that VWnote uses to display the sensors built-in temperature sensor is ºC
- You can select the optional ºF
- Press → to toggle between C and F. Press '**Save**' to commit the change to VWnote or ← to cancel the change you have just made.

4. SAVE WAVE FORM:

- VWnote can be set up to capture the wave form of the sensor signal from the selected sensor for diagnostic purposes.
- The default selection is '**NO**' (do not save wave form).
- You can change it to '**YES**' (save wave form)
- Press → to toggle between '**NO**' and '**YES**'. Press '**Save**' to commit the change to VWnote, temporarily for this sensor and for this session, or ← to cancel the change you have just made.

Every time the VWnote is switched on, the setting for save wave form for all sensors in VWnote will be reset to '**NO**'.

5. DISPLAY RESOLUTION (DISPL. RESOL.):

- The display resolution for each sensor reading (in raw or engineering units) can be set to match your needs.
- The default value for this parameter is 0.001 (3 digits after the decimal point).
- You can select from 1, 0.1, 0.01, 0.001, 0.0001 (equivalent to 0, 1, 2, 3 and 4 digits after decimal point).
- Press → until the one you wish to use is displayed for this sensor. Press Save to commit the change to VWnote or ← to cancel the change you have just made.

6. RAW DATA UNIT:

- Although three raw data formats (Hz, $Hz^2/1000$ and period) are displayed by VWnote while the sensor is read, only one raw reading (in Hz or $Hz^2/1000$) is saved and used for conversion into reading in engineering units
- The default value for this parameter is $Hz^2/1000$
- Press → to toggle between $Hz^2/1000$ and Hz
- Press Save to commit your selection to VWnote or ← to cancel the change you have just made.

You can find the raw data unit on the calibration sheet of the VW sensor.

7. ENGINEERING UNIT NAME (ENG. UNIT NAME):

- This is the name of the engineering unit that you would like to use when the reading of this sensor is displayed and saved, such as kPa, psi and mH2O
- It is a text string with up to eight characters. Except "(comma)", all other alphanumeric characters and symbols (such as +, -, %, &, etc) are allowed.
- The default value for this parameter is 'blank'
- When entering an engineering unit name, use → to move the cursor to the next character position and use ↑ and ↓ to move through allowed characters
- Press '**Save**' to commit your entry to VWnote or ← to cancel the change you have just made.

Pressing ← during entry or edit will not move the cursor one character to the left. It will cancel the entry or edit and take you to the previous menu.

8. CALIBRATION FACTORS (CAL FACTORS):

- Calibration factors are used to convert sensor raw readings (defined above) into values in engineering units (also defined above)
- The default calibration is linear which requires a gauge factor (G) and a base reading (R0)
- Press → to go to the screen where you can select between '**LINEAR (G and R0)**' and '**POLYNOMIAL (ABC)**'
- If you select '**LINEAR**', pressing → will take you to the two screens where you can review, enter or edit G and R0

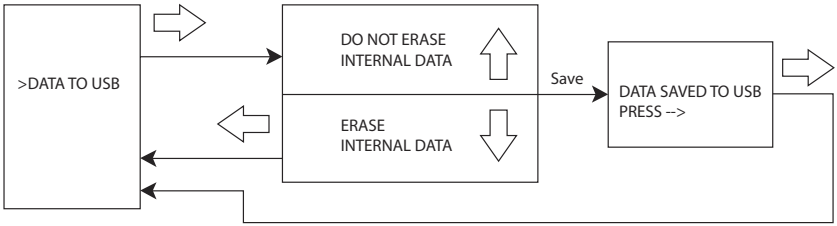
- If you select POLYNOMIAL:
  1. Pressing → will take you to the next screen where you can view, enter or edit the value of A.
  2. Pressing up and down will display other screens displaying value of B and '**R0 or C? PRESS →** '.
  3. Pressing → when '**R0 or C?**' is displayed will take you to two further screens for R0 and C.
  4. Use ↑ and ↓ to select which option you want. The last one you view before you press '**Save**' will be used in the calculation from raw reading to engineering unit.
- When entering a numeric value, use → to move the cursor to the next character position and use ↑ and ↓ to move through 0-9 and '-' and '**E**', where '**E**' is for entering numeric values with exponent, for example 1.234E-8 for 1.234 x 10^{-8}.
- When you are making an edit, press '**Save**' to commit your entry to VWnote or ← to cancel the change you have just made.

Pressing ← during entry or edit will not move the cursor one character to the left. It will cancel the entry or edit and take you to the previous menu.

The value for R0 is in raw data units, such as Hz or $Hz^2/1000$.
More information on sensor calibration factors is given later in *Appendix A* in *Part V*.

The DATA TO USB Menu

You don't need a site PC to download saved data from the VWnote. Instead, you transfer the saved data to a USB pen drive then transfer the data to a PC, which need not be in the same office or the same site as the VWnote.

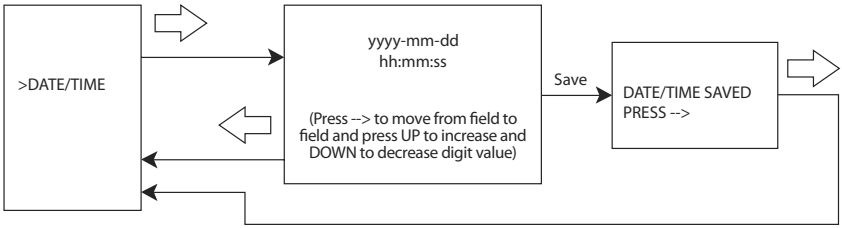


STEP	ACTION
1	Insert the USB pen drive into the USB slot on the bottom of the VWnote.
2	On the VWnote, navigate through the menu to '**DATA TO USB**' and press ➔.
3	You then have two options '**DO NOT ERASE INTERNAL DATA**' or '**ERASE INTERNAL DATA**'; scroll between the two options using ↑ and ↓, choose your option and press the '**Save**' button.
4	Note: choosing '**ERASE INTERNAL DATA**' will erase the data after the transfer to the USB; choosing '**DO NOT ERASE INTERNAL DATA**' will keep whatever data is in the VWnote internal memory intact.
5	The screen will say '**DATA SAVED TO USB. PRESS ➔**'. Pressing ➔ will take you back to the menu.
6	Remove the USB pen drive from the VWnote, remembering to replace the protective cap on the USB port. The data is now on the USB.

The format of the data files will be discussed in more detail in ***Part III***.

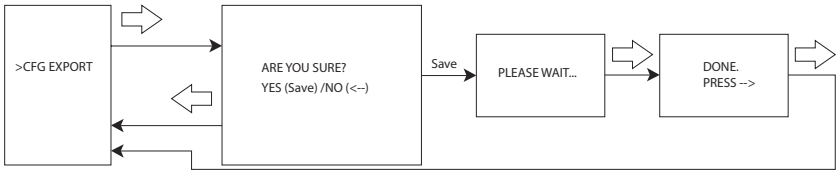
The DATE /TIME Menu

Select this menu item to update the date and time of the VWnote internal clock. The date is in ISO format (YYYY-MM-DD). Use → to move the cursor from the field of year to fields of month, day, hour, minute, second and back to year, and so on. While in each field, use ↑ and ↓ to increase or decrease the value of that field. Press '**Save**' to commit the changes to VWnote internal clock. This menu only needs to be executed occasionally.



The CFG EXPORT Menu

If you have added new sensors to the VWnote or made changes to the sensor configuration in the VWnote using the keypad, you can back up the sensor configuration to a pen drive using this menu item.

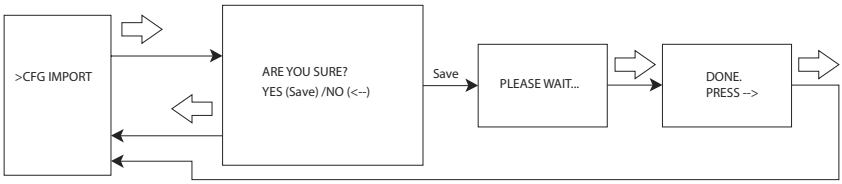


STEP	ACTION
1	Ensure the VWnote is switched on.
2	Insert the USB pen drive into the USB port on the base of VWnote.
3	Press ↑ and ↓ to scroll through the main menu until you find '**CFG EXPORT**'.
4	Select this option using the →, you will see a message saying '**ARE YOU SURE? YES (Save)/NO (←)**'
5	Press '**Save**' to proceed or ← to cancel and return to the previous screen.

The sensor configuration in the VWnote will be saved in the root folder on the USB pen drive with the file name '**VW_CONF0.vwn**'. It will overwrite any file with the same name in the root folder.

The CFG IMPORT Menu

In addition to entering sensor configuration using the keypad, you can produce a sensor configuration file on your PC using the VWnote Configuration Tool software. For the import to work, the configuration file must be named as '**VW_CONF0.vwn**' and reside in the root folder on the USB pen drive.



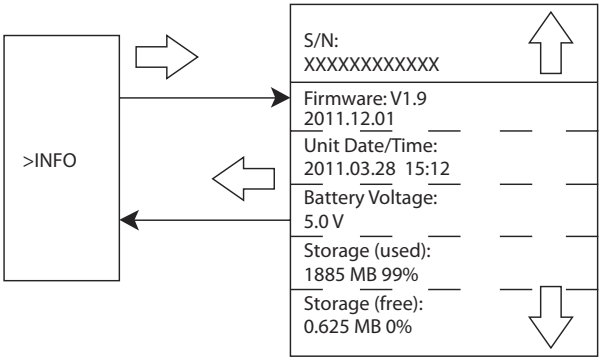
STEP	ACTION
1	Ensure the VWnote is switched on.
2	Insert the USB pen drive into the USB port on the base of VWnote.
3	Press ↑ and ↓ to scroll through the main menu until you find '**CFG IMPORT**'.
4	Select this option using the →, you will see a message saying '**ARE YOU SURE? YES (Save)/NO (←)**'.
5	Press '**Save**' to proceed or ← to cancel and return to the previous screen.

The sensor configuration in the VWnote will be overwritten by that in the configuration file.

The INFO Menu

This menu item allows you to view information about the VWnote. The information includes:

- VWnote serial number
- Firmware version number and compilation date of firmware
- Data and time of the VWnote's internal clock
- Storage capacity in MB (used)
- Storage capacity in MB (free).



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Part III – Guide to the Configuration File and the Data File

Contents

This section contains the following topics.

TOPIC	SEE PAGE
VWnote Sensor Configuration	39
Building a Sensor Configuration File	40
Finding and Interpreting Data Files	48

VWnote Sensor Configuration

Two of the most powerful features of the VWnote are:

- **It provides you with a default reading method that will allow you to read most of the sensors most of the time.**
- **It allows you to define:**
  1. A list of sensors, stored in the VWnote, to be monitored.
  2. The unique way that each sensor is energised and read.
  3. The unique way that results from each sensor are displayed and stored.

Content of the Sensor Configuration File

The Sensor Configuration File contains the following eight parameters that define how each sensor is read and how the readings are displayed.

1. SWEEP FREQUENCY:

In most cases, the default sweep frequency range (450-6000 Hz) works well because VWnote uses FFT reading algorithm to derive readings from the sensor. Optionally, you can customise the sweep frequency to any range between 450 Hz and 6000 Hz, such as 450-1250 Hz or 1200-2800 Hz.

2. EXCITATION VOLTAGE:

The default excitation voltage that VWnote uses to energise the sensor before taking a reading is 5 VDC. This is sufficient for most site conditions where the sensors have a short to medium cable length. You can select the optional 15 VDC excitation if the sensor has a long cable. The maximum cable length that 5 VDC excitation will work is dependent on factors such as the gauge size of the wires. However, as a rule of thumb, cable lengths greater than 200m (600ft) are usually considered to be long.

3. TEMPERATURE UNIT:

By default, temperature readings will be displayed as °C. Optionally, you can select °F

4. SAVE WAVE FORM:

VWnote can be set up to capture the wave form of the sensor signal from the selected sensor for diagnostic purposes. The default selection is '**NO**' (do not save wave form). You can change it to '**YES**' (save wave form) temporarily for a selected sensor. Every time the VWnote is switched on, the setting for save wave form for all sensors in VWnote will be reset to '**NO**'.

5. DISPLAY RESOLUTION:

The display resolution for each sensor reading (in raw or engineering units) can be set to match your needs. The default value for this parameter is 0.001 (3 digits after the decimal point). You can select from 1, 0.1, 0.01, 0.001, 0.0001 (equivalent to 0, 1, 2, 3 and 4 digits after decimal point).

6. RAW DATA UNIT:

This defines the raw reading (in Hz or $Hz^2/1000$) that is saved and used for conversion into reading in engineering units. The default value for this parameter is $Hz^2/1000$.

7. ENGINEERING UNIT NAME:

This is the name of the engineering unit that you would like to use when the reading of this sensor is displayed and saved, such as kPa, psi and mH_2O. It is a text string with up to 8 characters. The default value for this parameter is "blank".

8. CALIBRATION FACTORS:

Calibration factors are used to convert sensor raw readings (defined above) into values in engineering units (also defined above). The default calibration is linear which requires a gauge factor (G) and a base reading (R0). If you select polynomial you will need to enter A, B and R0 or C, where the value for R0 is in raw data units, such as Hz or $Hz^2/1000$.

Please see *Appendix A in Part V* of this manual for a more detailed description of the calibration factors.

Building a Sensor Configuration File

You can build the list of sensors with configuration in two ways:

- **Using the keypad on the VWnote to create and edit the list in the VWnote's internal memory.**
- **Using the VWnote Configuration Tool software (supplied free of charge) to create and maintain the Sensor Configuration File on your PC, then transfer it to the VWnote's internal memory using a USB pen drive.**

BUILDING WITH VWNOTE KEYPAD

This was covered in detail in ***Part II***.

BUILDING WITH VWNOTE CONFIGURATION TOOL

VWnote Configuration Tool is a piece of Windows PC-based software written to create and maintain the sensor configuration files. It is supplied free with the VWnote. You can also download a copy of the latest version from www.itmsoilsupport.com.

INSTALLING THE VWNOTE CONFIGURATION TOOL

The latest version of VWnote Configuration Tool is distributed free on the USB pen drive delivered with each VWnote. It is a single exe file named '**VWnote Configuration Tool .exe**' residing in the VWnote software folder on the USB pen drive. There is no need to run a set up program to install it.

VWnote Configuration Tool requires '**Microsoft .NET Framework 3.5**' to run. On modern PCs running '**Windows 7**' or above, '**.NET Framework**' is already installed. Download a copy from Microsoft.com if you are running an older operating system, such as '**Windows XP**', and do not have it on your PC yet.

RUNNING THE VWNOTE CONFIGURATION TOOL

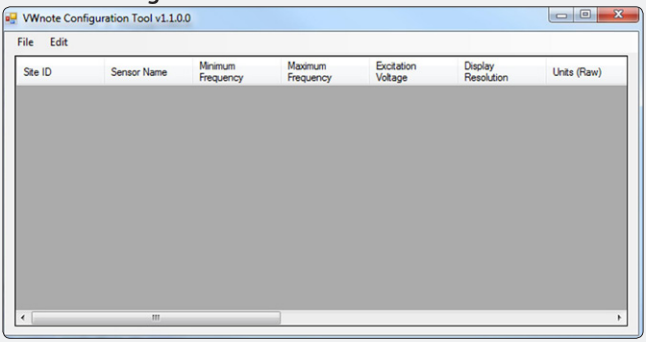
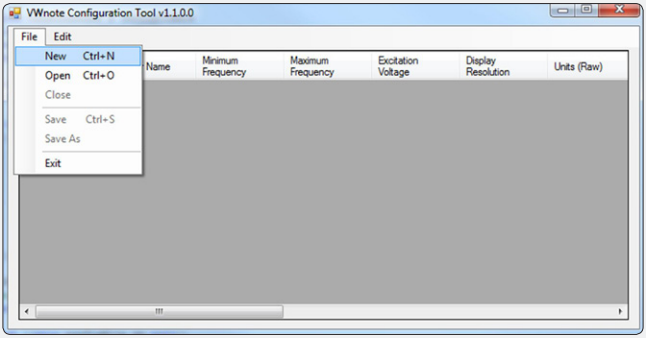
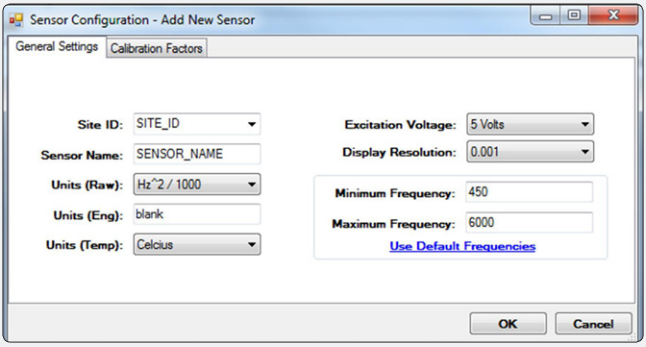
You will need the following items before running the Tool:

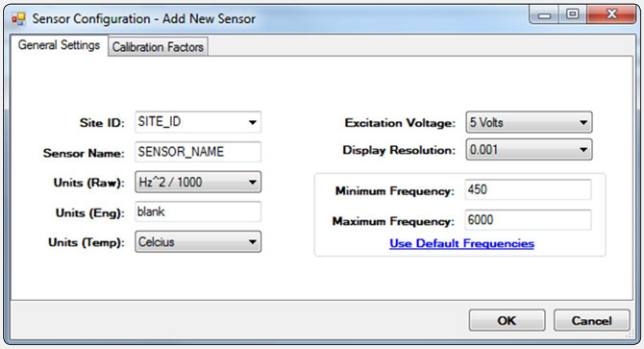
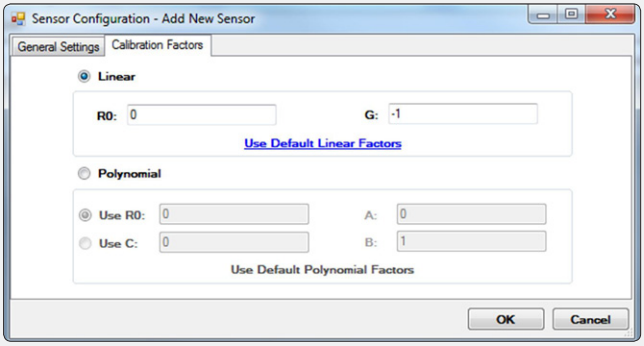
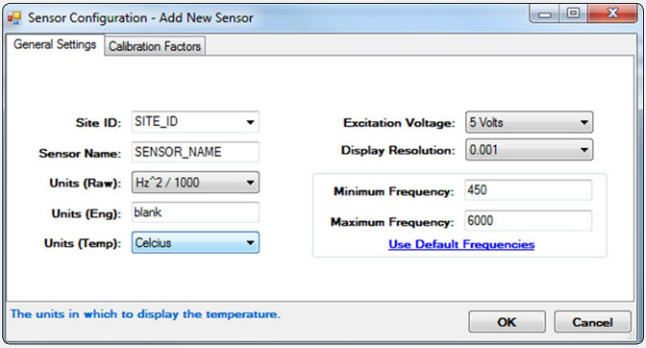
- **A Windows PC with the following minimum PC requirements**
- **A USB pen drive with the VWnote Configuration Tool software.**

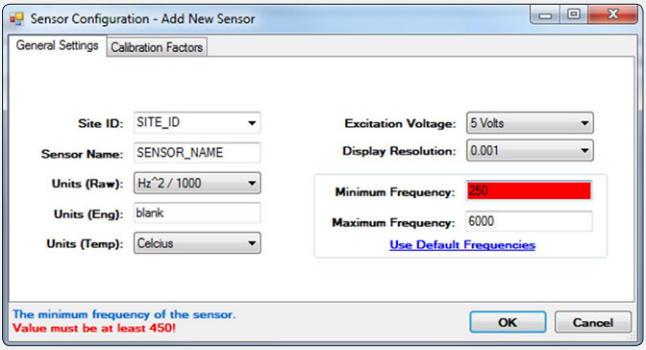
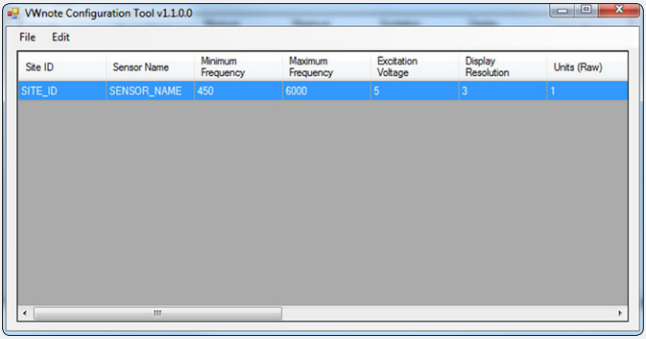
The PC running the VWnote software must have the following minimum requirements:

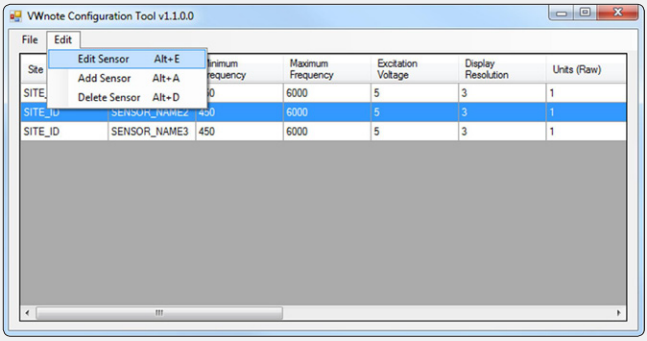
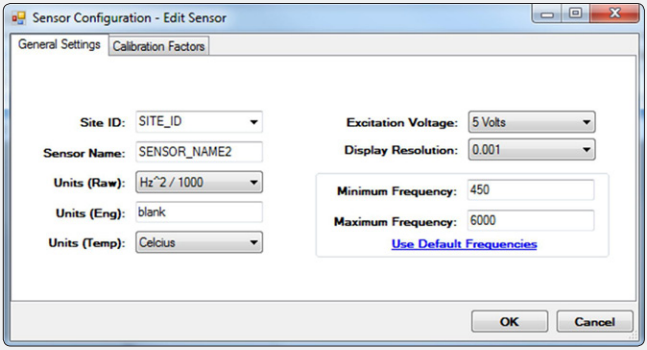
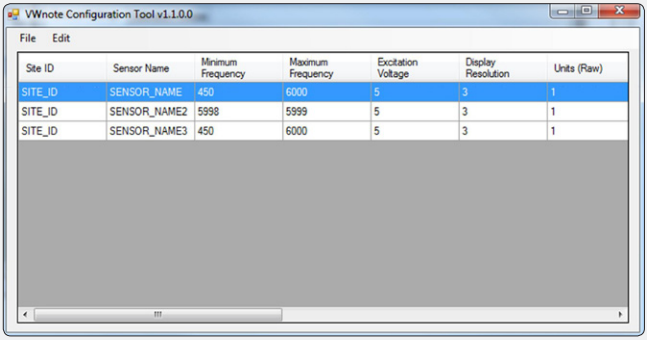
- **'Windows XP' and above operating system**
- **Pentium 4, 1 GHz or better specification**
- **1 GB RAM**
- **40 GB hard drive or solid state drive**
- **USB port interface.**

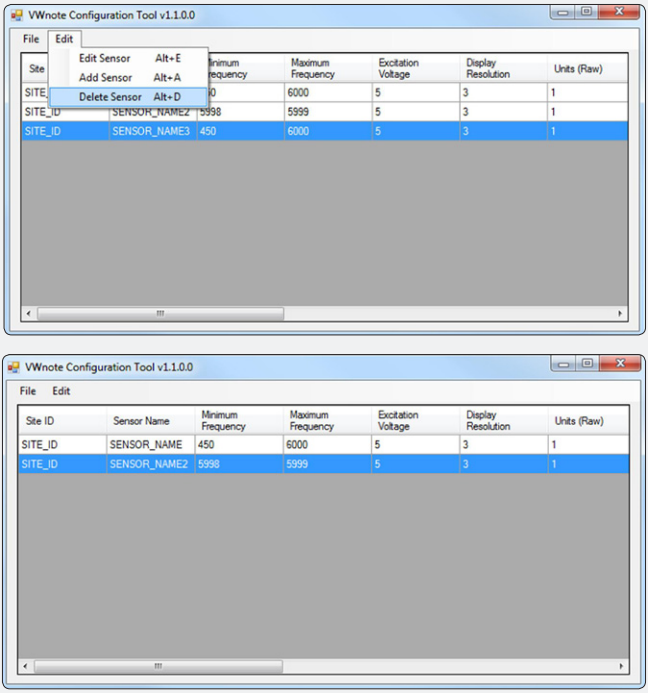
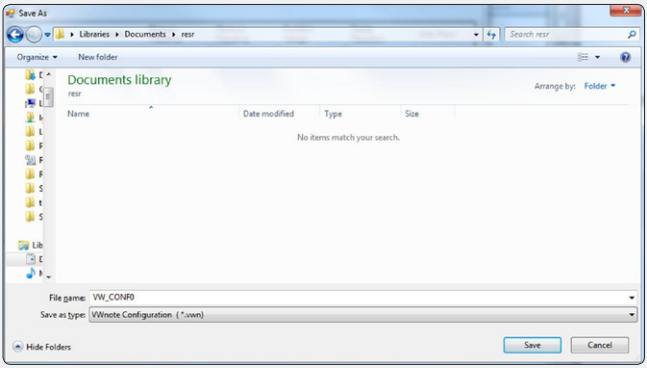
You can run the Tool directly on the USB pen drive or you can copy it on to the hard drive on your PC and run it from there.

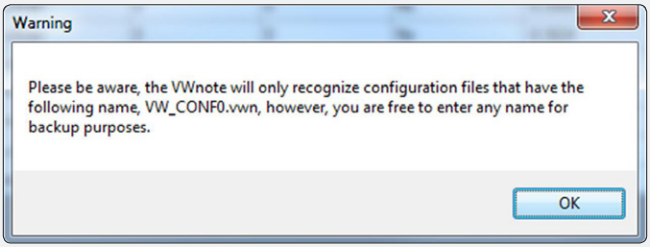
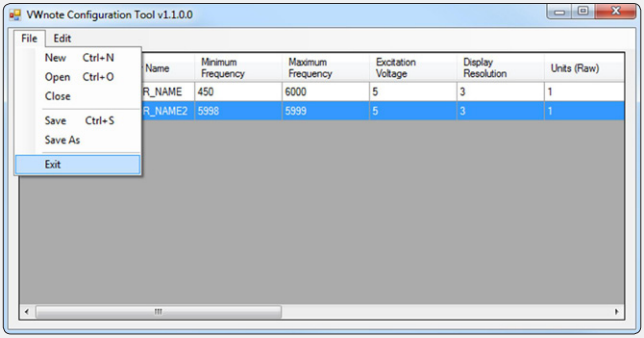
STEP	ACTION
1	Insert the VWnote USB pen drive into the PC.
2	Open the VWnote software folder on the pen drive and run '**VWnote Configuration Tool.exe**'. 
3	Click on '**File**' then '**New**' to create a new configuration file. 
4	After you elect to create a new configuration file, the '**Add New Sensor**' window will be displayed to allow you to add a new sensor to the configuration file. 

STEP	ACTION
5	Click on either the 'General Settings' or 'Calibration Factors' tab on the Sensor Configuration Window. Clicking on the **Cancel** button will cancel the addition of a new Sensor Configuration.  
6	Hovering over an input field with the mouse will bring up a short description of that field. 

STEP	ACTION
7	When you have finished filling in the details, click '**OK'** to continue. If there is an error in any field, it will be highlighted in red – mouse over the highlighted field to show the error message on the bottom left of the window. 
8	If there was no error, the '**Sensor Configuration**' Window will close and you will see the new '**Sensor Configuration**' in the data table on the main '**Configuration Tool Window**'. 
9	To add another Sensor Configuration, go back to step 4.

STEP	ACTION
10	To edit an existing Sensor Configuration, select the configuration you want to edit and go to '**Edit**' then '**Edit Sensor'**. 
11	This will bring up the '**Sensor Configuration**' window, with the details for the selected configuration. Clicking on the '**Cancel**' button will cancel any changes to the selected '**Sensor Configuration**'. 
12	Click the '**OK**' button to save the changes. You will be returned to the main '**Configuration Tool**' Window. 

STEP	ACTION
13	To delete a '**Sensor Configuration**', select the configuration you want to delete and click on '**Edit'** then '**Delete Sensor'**. This will remove the Sensor Configuration from the list.  VWnote Configuration Tool v1.1.0.0 File Edit Edit Sensor Alt+E Add Sensor Alt+A Delete Sensor Alt+D Site ID Sensor Name Minimum Frequency Maximum Frequency Excitation Voltage Display Resolution Units (Raw) SITE_ID SENSOR_NAME2 5998 5999 5 3 1 SITE_ID SENSOR_NAME3 450 6000 5 3 1 VWnote Configuration Tool v1.1.0.0 File Edit Site ID Sensor Name Minimum Frequency Maximum Frequency Excitation Voltage Display Resolution Units (Raw) SITE_ID SENSOR_NAME 450 6000 5 3 1 SITE_ID SENSOR_NAME2 5998 5999 5 3 1
14	To save the '**Sensor Configurations**', go to '**File**' then '**Save**'. If you created a new file, the '**Save File Dialogue**' will display. Type in a name for the file or accept the recommended name and click '**Save'**.  Save As Libraries Documents resr Search resr Organize New folder Documents library resr Arrange by: Folder Name Date modified Type Size No items match your search. File name: VW_CONF0 Save as type: VWnote Configuration (*.vwn) Hide Folders Save Cancel

STEP	ACTION
15	If you edited an existing file, '**File**'-'**Save**' will save it over the existing configuration file without asking.
16	When you are asked to enter or confirm a file name, a warning message will appear alerting that VWnote will only recognise '**VW_CONF0.vwn**' while performing '**CFG IMPORT**'. 
17	To exit the program, click on '**File**' then '**Exit**', or click the red '**X**' in the upper right corner of the window. 

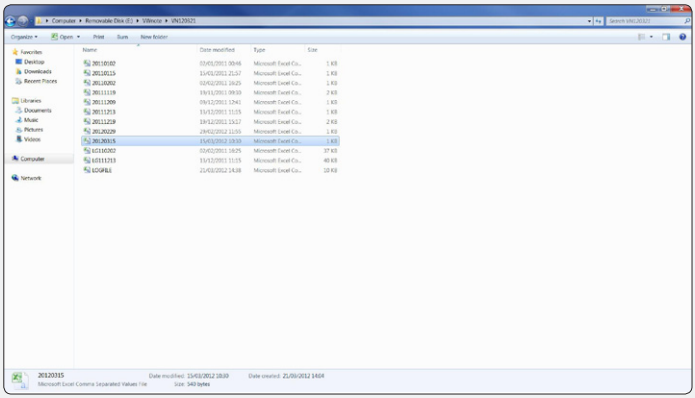
Finding and interpreting data files

LOCATING DATA FILES

The data collected from a VWnote is stored internally and retrieved using a USB pen drive.

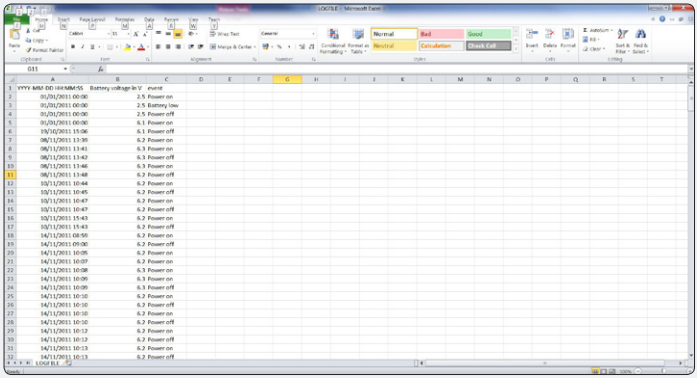
When you open the pen drive folder on a PC or laptop, you will find a folder has been created with the name made up of the prefix '**VN'** and the download date in the format YYMMDD, for example '**VN130321**' shows the data downloaded on 21 March 2013.

Double-click on the folder to open it and you will see one or more Excel-compatible '**.CSV files**'. Each file is named by the date of the readings taken in the format YYYYMMDD; for example, '**20130321.csv**' is a file of the readings taken on 21 March 2013. Only one file per day is created.

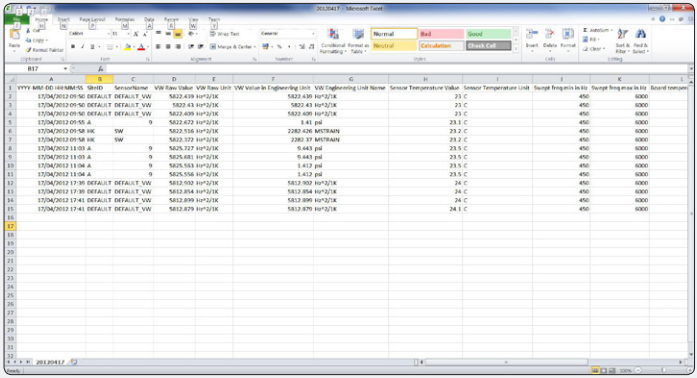


If you downloaded the data when older readings had not been erased from the internal memory on the previous download, each set of readings will be shown in an Excel-compatible '**.CSV file**'. However, if you downloaded data after all internal data had been erased during a previous download, then there should only be one reading file plus a Logfile (**LOGFILE.CSV**).

The Logfile is simply a record of events such as powering on or low battery, with a note of the battery voltage; this is for diagnostic purposes only and you may ignore it.



Click on a readings file to open it (further explanation of the data shown is given in the next subsection).



INTERPRETING THE DATA FILE

The data file is in '**comma separated value**' (**CSV**). The field delimiter symbol is the "**,**" (**comma**) character. The record delimiter string in the CSV file is '**CR+LF**' characters (**carriage return and line feed**).

There is a header line appearing as the first line of the file with the same format as normal record lines. This header contains names corresponding to the fields in the file and contains the same number of fields as the records in the rest of the file.

The table below shows the fields in the data file for each line.

COLUMN	FIELD NAME	FORMAT
1	Date/Time	yyyy-mm-dd hh:mm:ss
2	Site name	Text, 10 chrs, A-Z, 0-9, _
3	Sensor name	Text, 15 chrs, A-Z, 0-9, _
4	VW raw reading	Number, floating point
5	VW raw reading unit name	Hz or Hz^2/1000
6	VW reading in engineering unit	Number, floating point
7	Engineering unit name	Text, 8 chrs
8	Temperature reading	Number, floating point
9	Temperature	°C or °F
10	Start sweep frequency	Number, integer
11	End sweep frequency	Number, integer
12	VWnote internal temp. in °C	Number, floating point
13	VWnote battery voltage	Number, floating point
14	AMPL in mV	Number, floating point
15	SNR	Number, floating point
16	Noise frequency	Number, floating point
17	Decay ratio	Number, floating point

DATA STORAGE AND HANDLING

The standard internal memory capacity of the VWnote is 2GB, which is sufficient to store over 6 million sets of readings and the configuration parameters of several thousands of sensors.

It is possible to increase the memory size but research at Soil Instruments has shown that 2GB is more than ample storage.

Part IV – Maintenance Guide

Contents

This section contains the following topics.

TOPIC	SEE PAGE
Routine Maintenance	52
Battery Maintenance	52
Calibration	53
Firmware and Software Updates	53

Routine Maintenance

BATTERY MAINTENANCE

The VWnote is manufactured with a multi-layer circuit board containing surface mount components. For this reason there are no parts which require routine maintenance.

The VWnote is supplied with a Nickel Metal Hydride (NiMH) rechargeable battery. Although the battery requires no maintenance as such, it is important to follow the charging procedure outlined below at all times to correctly maintain the battery.

As rechargeable batteries decay over time, the VWnote battery will be tested and replaced if necessary, during annual re-calibration.

STEP	ACTION
1	Make sure the VWnote is switched off
2	Remove the protective cap from the charging point, located on the top of the VWnote
3	Plug the connector into the charging point on the VWnote, making sure to align the connections correctly
4	Plug the charging unit into a mains power socket
5	Switch on the mains power to the charging unit
6	The LED on the charging unit will follow the sequence outlined in the table below
7	Place the protective cap back into the charging point on the VWnote when charging is complete

Charging Unit LED Sequence

STEP	LED	STATUS
1	Red - Green	Analysing battery status
2	Red - Green	
3	Red	Charging in progress
4	Green	VWnote charged; switched to trickle charge mode

Follow the charging procedure outlined in this manual at all times to properly maintain the battery.

Battery life: Battery life is a function of a combination of the following factors;

- Battery type
- Sensor type
- How often the VWnote is used to take reading
- How often the data are offloaded
- How often the backlight is switched on
- Ambient temperature.

In designing the VWnote system, Soil Instruments have produced firmware routines to maximise the battery life. As a rule of thumb, the VWnote can achieve battery life of up to 30 hours without backlight and 15 hours with the backlight switched on.

To maximise battery life, the VWnote has an inbuilt off timer. When the VWnote has been inactive for six minutes it will automatically turn off.

Battery voltage: The VWnote saves its battery voltage with every reading to enable batteries to be monitored and recharged in a timely manner. The battery voltage in the VWnote should be above 5.0 volts for the VWnote reading circuitry to work. If the voltage goes below 3.6 volts, the VWnote will shut off.

CALIBRATION

Each VWnote is calibrated before it is shipped. To meet your calibration needs, we offer re-calibration services at our facilities. If you intend shipping the VWnote back to our factory. please contact Soil Instruments or our distributors for more information.

FIRMWARE AND SOFTWARE UPDATE

From time to time, Soil Instruments may issue updates to the firmware and the VWnote Configuration Tool for additional features or bug fixes. Details of how to update these will be provided as the situation arises.

Part V – Appendices

Contents

This section contains the following topics.

TOPIC	SEE PAGE
Appendix A – How to Apply CalibrationFactors for Sensors	55
Appendix B – Definition of Fast Fourier Transform (FFT)	57
Appendix C – Frequently Asked Questions/Troubleshooting Guide	58

Appendix A – How to apply Calibration Factors for VW Sensors

The calibration certificate for your VW sensor will provide you with the information on how to convert the raw readings into readings in engineering units.

Below is an example of calibration certificate from Soil Instruments:

BS EN ISO 9001:2008
FM 553710

itmsoil

Bell Lane, Uckfield, East Sussex
TN22 1QL United Kingdom

t: +44 (0) 1825 765044
f: +44 (0) 1825 744398

e: info@itmsoil.com
w: www.itmsoil.com

itmsoil Holdings Ltd. Registered in England. Number: 4239206. Registered Office: Bell Lane, Uckfield, East Sussex TN22 1QL.

VIBRATING WIRE INSTRUMENTS CALIBRATION CERTIFICATE

Instrument Type : E10 Displacement Transducer
Serial No. : 042564

Instrument Range : 0.00 to 50.0 mm
Calibration Date : 19/01/2012

Gauge Factors in mm
Ambient Temperature : 23°C

Period Gauge Factor (K): -92.1072800
Barometric Pressure : 1016 mbar

Linear Gauge Factor (G): (mm/digit)-0.0092100
Calibration Technician : Wayne Diprose

Polynomial Gauge Factor A: 0.000000024979630
Calibration Equipment:
Digital Micrometer Scale

Polynomial Gauge Factor B: 0.0089164270
Vibrating Wire Logger Serial No. 636

Polynomial Gauge Factor C: -28.551660**
Regression Zero : 3185.9

Applied (mm)	Reading (Period)	Reading F²/1000	Calculated (Linear)	Error %FS (Linear)	Linear Increment	Calculated (Polynomial)	Error %FS (Polynomial)
0.00	5610.9	3176.4	-0.088	-0.18	0.0	0.023	0.05
5.00	5182.9	3722.6	4.943	-0.11	546.2	4.987	-0.03
10.00	4840.0	4268.8	9.974	-0.05	546.2	9.966	-0.07
15.00	4555.8	4818.0	15.032	0.06	549.2	14.988	-0.02
20.00	4316.6	5366.8	20.087	0.17	548.8	20.021	0.04
25.00	4112.2	5913.5	25.123	0.25	546.7	25.049	0.10
30.00	3937.9	6448.8	30.053	0.11	535.3	29.987	-0.03
35.00	3782.8	6988.5	35.024	0.05	539.7	34.981	-0.04
40.00	3643.9	7531.2	40.023	0.05	542.7	40.017	0.03
45.00	3521.8	8062.5	44.917	-0.17	531.3	44.961	-0.08
50.00	3409.0	8604.8	49.912	-0.18	542.3	50.022	0.04

Formulae: Linear* $E = G(R0 - R1)$
Polynomial** $E = AR1^2 + BR1 + C$

* The zero reading should be established on site by the user on installation.
** The site value of C must be calculated using the formula $C = -(AR0^2 + BR0)$

The instrument detailed hereon has, as applicable, been inspected, tested and calibrated in accordance with ISO 9001:2008 approved procedures and, unless otherwise indicated, performs within ± 0.20% (Polynomial) as specified. Thus, the instrument conforms in all respects to our relevant specifications and drawings.

Certified: ..... Line MANAGER

Calculation of engineering units from frequency readings of VW sensors

The mathematical relationship between the resonance frequency of a tensioned wire and the force applying the tension is represented by a near straight line relationship between the square of the frequency (Hz^2) and the applied force.

The sensor readings in frequency can be converted to measurements in engineering units (such as mm, kPa or psi) using the following equations:

CALCULATION USING LINEAR EQUATION

The following equation is used for readings in $Hz^2/1000$:

$$E = G \times (R0 - R1)$$

where:

E is the resultant Engineering unit
G is the linear Gauge factor for the units of calibration
R0 is the 'base' or 'zero' reading (in $Hz^2/1000$) taken at the time of installation
R1 is the current reading in $Hz^2/1000$.

CALCULATION USING POLYNOMIAL EQUATION

The polynomial formula for all Soil Instruments VW sensors is:

$$E = A \times R1^2 + B \times R1 + C$$

where:

E is the resultant value in Engineering units
A, B and **C** are the polynomial factors from the calibration sheet
R1 is the current reading in $Hz^2/1000$

It should be noted that **C** is an offset value derived from a 'base' reading in the factory where the sensor calibration is performed. Soil Instruments recommend the value for **C** should be recalculated at the time of installation from the **R0** as follows:

$$C = -(A \times R0^2 + B \times R0)$$

VWnote allows you to enter either **C** or **R0** in the sensor configuration. If you choose to enter **R0**, the VWnote will recalculate the **C** for you before performing the raw to engineering unit conversion.

Appendix B – Definition of Fast Fourier Transform (FFT)

FFT (FAST FOURIER TRANSFORM)

Any time-varying signal (a musical sound for instance) will be composed of one or more component frequencies of different amplitudes.

The Fast Fourier Transform (FFT) algorithm is a fast and efficient method of determining what those component frequencies are, along with their respective amplitudes.

How to make use of the quality indices

Below is some simple guidance on how quality indices can be used to determine the quality of the reading.

- **AMPL:** The value of this index depends on the type of sensor but it should be more than 0.5 mV
- **SNR:** When the signal is good and noise is low, this value will be 200, 500, or more. It can drop to single figures in a very noisy environment. Based on experience, any reading with **SNR** less than 5 should be ignored and retaken
- **NOISE F:** Ideally, this value should be far from the sensor reading in Hz. If this value is very near the sensor reading you expect, then the result you are getting may be invalid
- **DECAY RATIO:** The value of this index is dependent upon the type and quality of the sensor. The value should be between 0 and 1 (representing 0%-100%). While the higher the value the better, a value greater than 1 would suggest a bad sensor.

Appendix C – Frequently Asked Questions/Troubleshooting guide

What happens if I drop the VWnote unit?

The VWnote has been subjected to a drop test from a one metre height onto a concrete surface. The VWnote is supplied with a wrist strap so you can keep it attached to your wrist when there is a drop risk. Please make use of it to avoid drop damage.

What do I do if my reading is unstable?

Answer 1: It may be that you have too many digits after the decimal point when you display the reading. The default setting is three digits. You may need to adjust the Display Resolution (DISPL. RESOL).

Answer 2: When you encounter unstable readings, you should check the four quality indices to determine whether the reading is good. If not, then you should take another reading. If the problem persists, you should re-try using a narrower sweep frequency range.

Why am I getting a display of "No VW sensor?" or "No Therm Sen.?"?

This means no VW sensor or no thermistor sensor is connected, or the sensor or the signal cable is faulty. Check the sensor lead is properly connected and then check the signal cable and the sensors.

What sweep frequency range should I use to read my VW sensors?

In most cases, the default sweep frequency range (450-6000 Hz) works well because VWnote uses FFT reading algorithm to derive readings from the sensor. Optionally, you can customise the sweep frequency to any range between 450 Hz and 6000 Hz, such as 450-1250 Hz or 1200-2800 Hz.

Will VWnote work at very low or very high temperatures?

The VWnote was tested and working after it had been in a temperature chamber for an hour at -10°C. At temperatures lower than -10°C, the LCD screen may become unreadable. The same test was conducted at +50°C and the VWnote functioned normally.

How do I make use of the quality indices?

Below is some simple guidance on how these indices can be used to determine the quality of the reading.

- **AMPL:** The value of this index depends on the type of sensor but it should be more than 0.5 mV.
- **SNR:** When the signal is good and noise is low, this value will be 200, 500, or more. It can drop to single figures in a very noisy environment. Based on experience, any reading with **SNR** less than 5 should be ignored and retaken.
- **NOISE F:** Ideally, this value should be far from the sensor reading in Hz. If this value is very near the sensor reading you expect, then the result you are getting may be invalid.
- **DECAY RATIO:** The value of this index is dependent upon the type and quality of the sensor. The value should be between 0 and 1 (representing 0%-100%). While the higher the value the better, a value greater than 1 would suggest a bad sensor.

What unit is Hz^2/1K?

Due to limited display space on the LCD screen, Hz^2/1000 is displayed as Hz^2/1K.

Why is my engineering unit displayed as 'blank'?

Before you can set up sensor configuration with proper engineering unit names in the VWnote, the engineering unit will be displayed as '**blank**', alerting you that it is not yet set.

SUPPORT

www.itmsoilsupport.co.uk

+44 (0) 1825 765044

Bell Lane, Uckfield, East Sussex
TN22 1QL United Kingdom

t: +44 (0) 1825 765044
f: +44 (0) 1825 744398

e: info@soil.co.uk
w: www.soil.co.uk

Soil Instruments Ltd. Registered in England. Number: 07960087. Registered Office: 34 Bell Lane, Uckfield, East Sussex, TN22 1QL.